US008033741B2

(12) **United States Patent**
Yoshikawa

(10) **Patent No.: US 8,033,741 B2**
(45) **Date of Patent: Oct. 11, 2011**

(54) **OPTICAL TRANSCEIVER WITH ENHANCED EMI TOLERANCE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/792,213**

(22) Filed: **Jun. 2, 2010**

(65) **Prior Publication Data**

US 2010/0310215 A1 Dec. 9, 2010

(30) **Foreign Application Priority Data**

Jun. 4, 2009 (JP) 2009-135168

(51) **Int. Cl.**
G02B 6/36 (2006.01)
H01R 13/648 (2006.01)

(52) **U.S. Cl.** **385/92**; 439/607.01; 439/607.2

(58) **Field of Classification Search** 385/92
See application file for complete search history.

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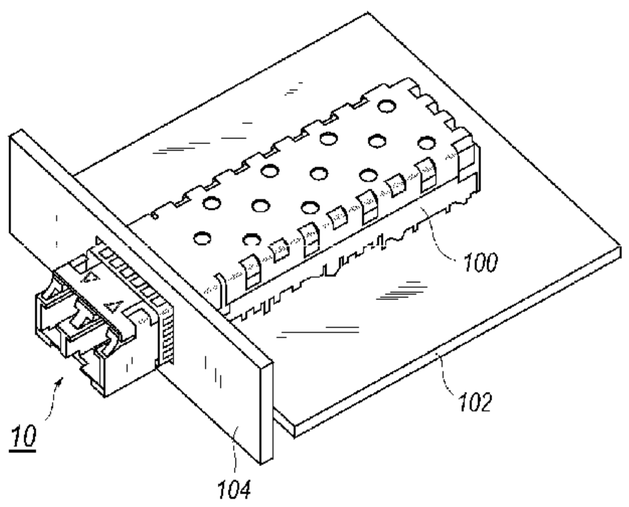
(57) **ABSTRACT**

A pluggable optical transceiver with an enhance EMI tolerance is disclosed. The optical transceiver provides an electrically conductive receptacle, a ground member made of metal sheet, and a cover also made of metal sheet. The ground member is assembled so as to surround a periphery of the receptacle. The cover provides a first bridge in a front portion thereof, while, the ground member provides fingers and a second bridge connecting the fingers in the tip portion. Fully setting the optical transceiver in the cage, the finger comes in contact with the inside of the cage and the first bridge comes in securely contact with the second bridge so as to shield a gap between the transceiver and the cage.

10 Claims, 6 Drawing Sheets



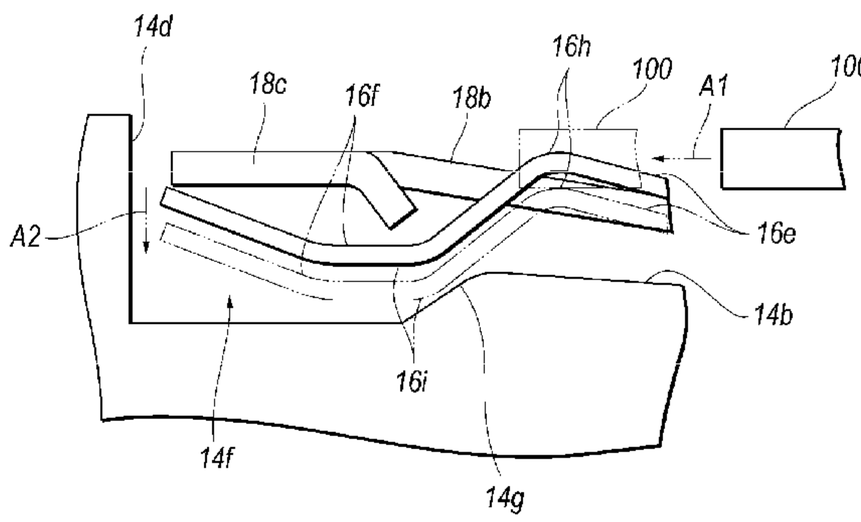


Fig. 1

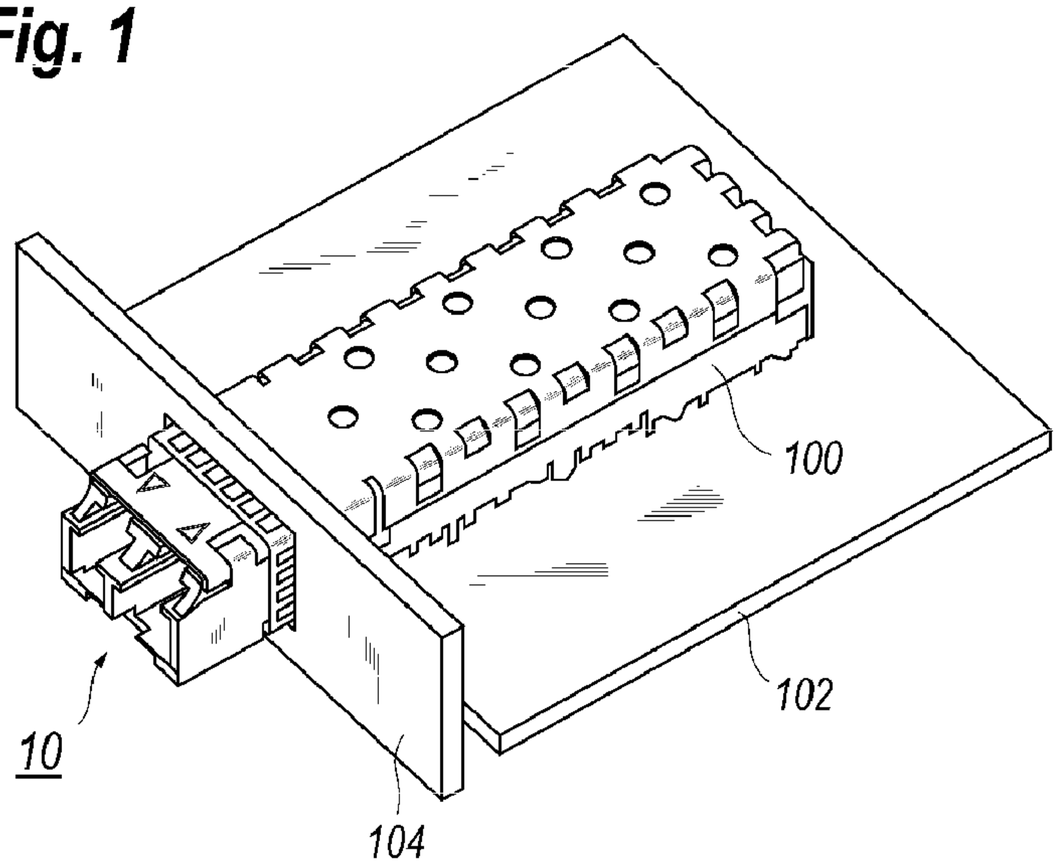
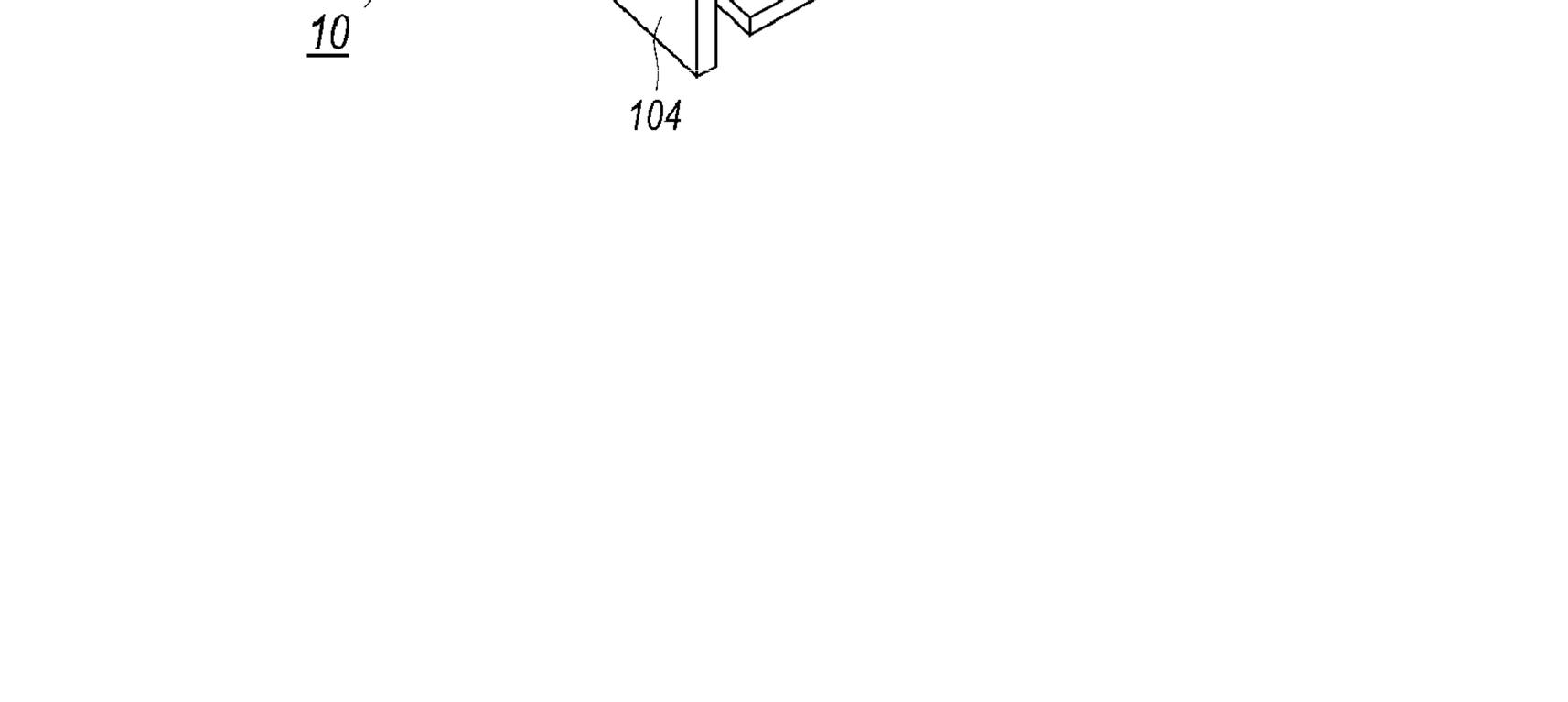


Fig. 2



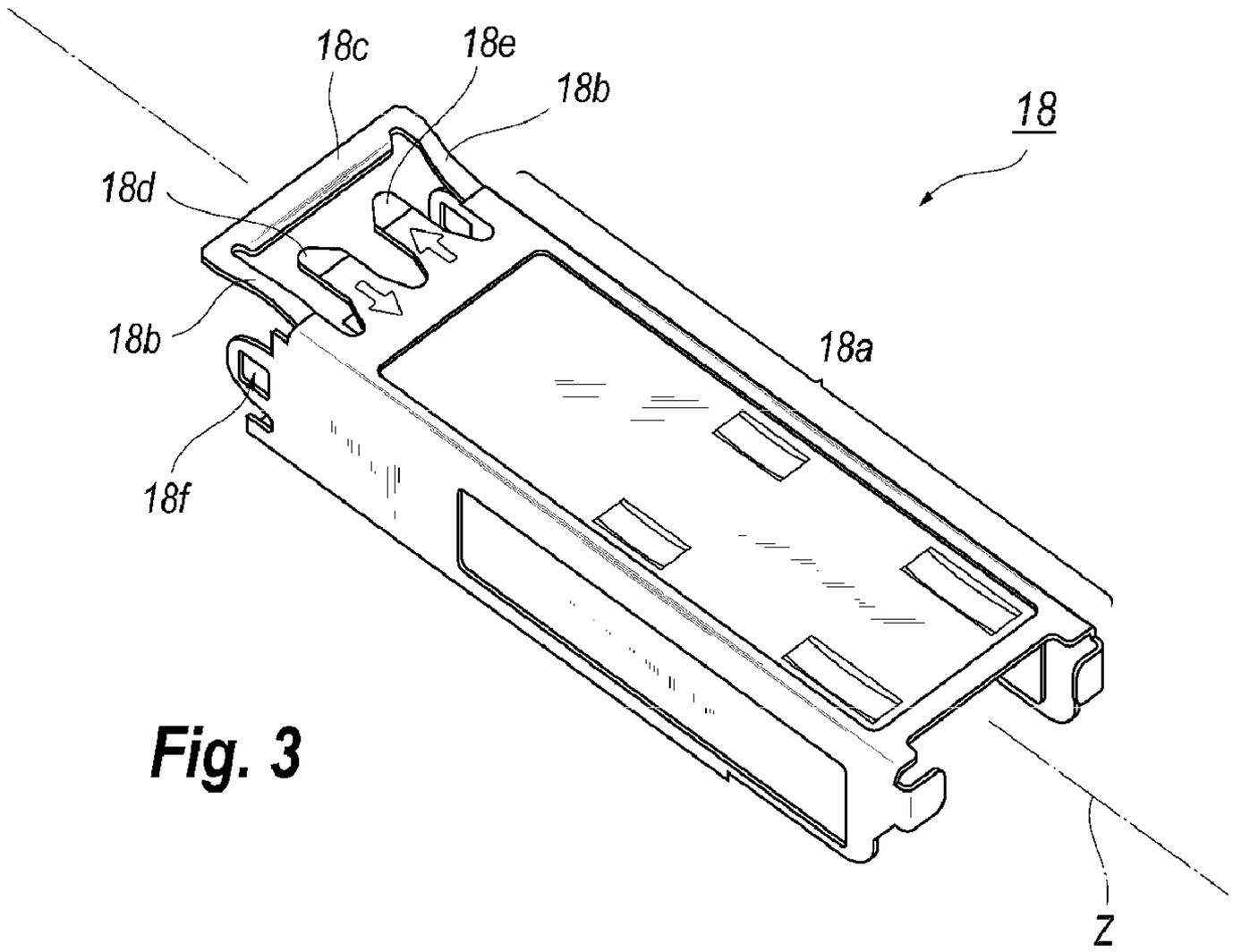


Fig. 3

Fig. 4

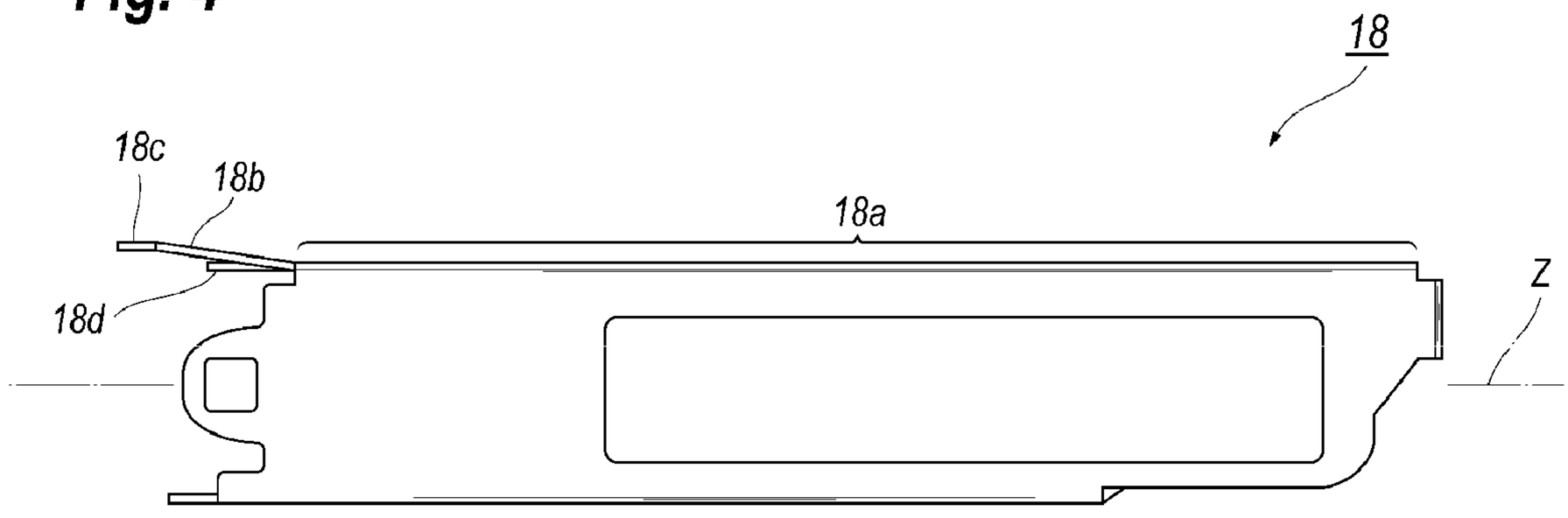


Fig. 5

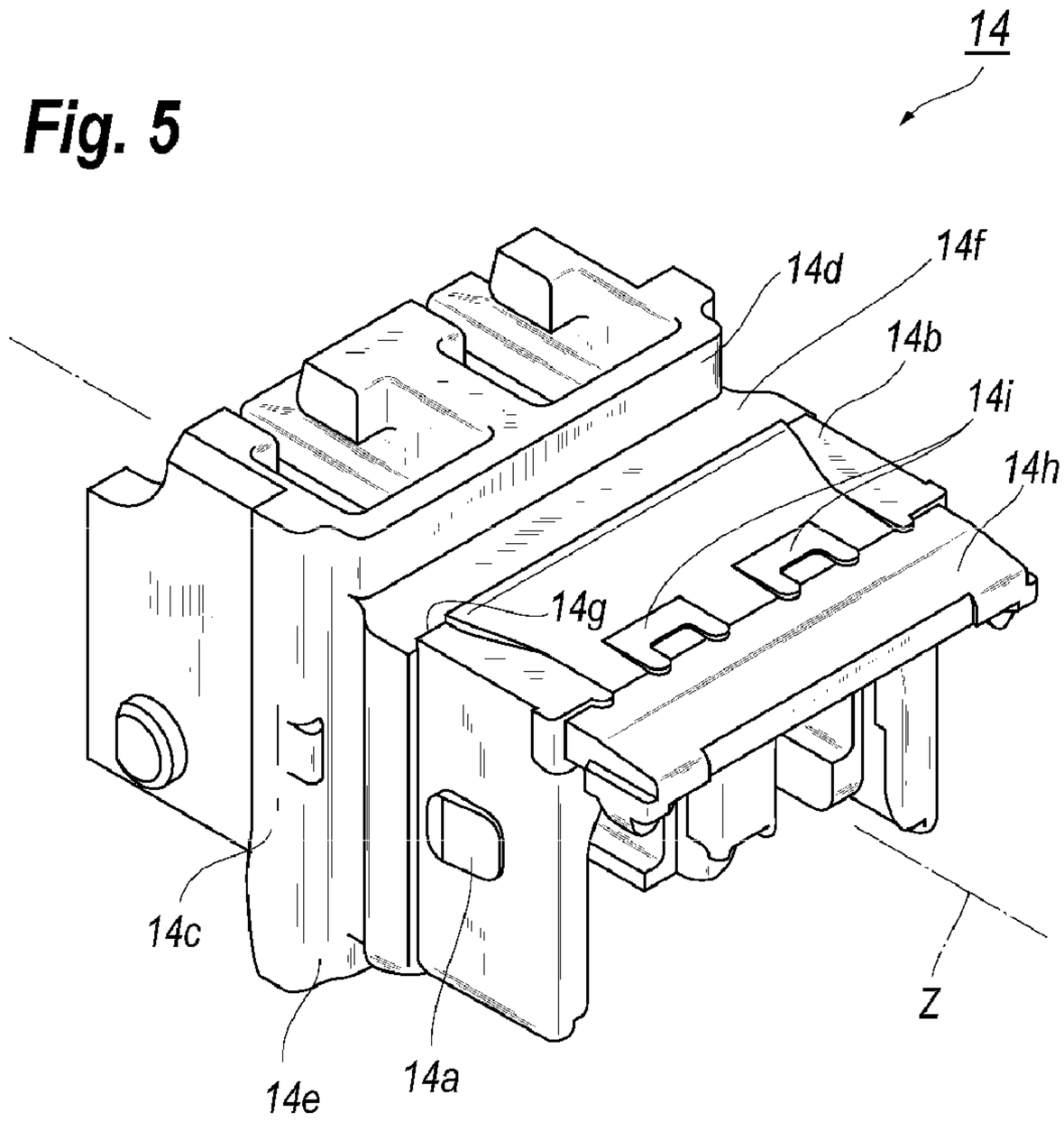

14
14d
14f
14b
14i
14h
14g
14c
14e
14a
Z

Fig. 6

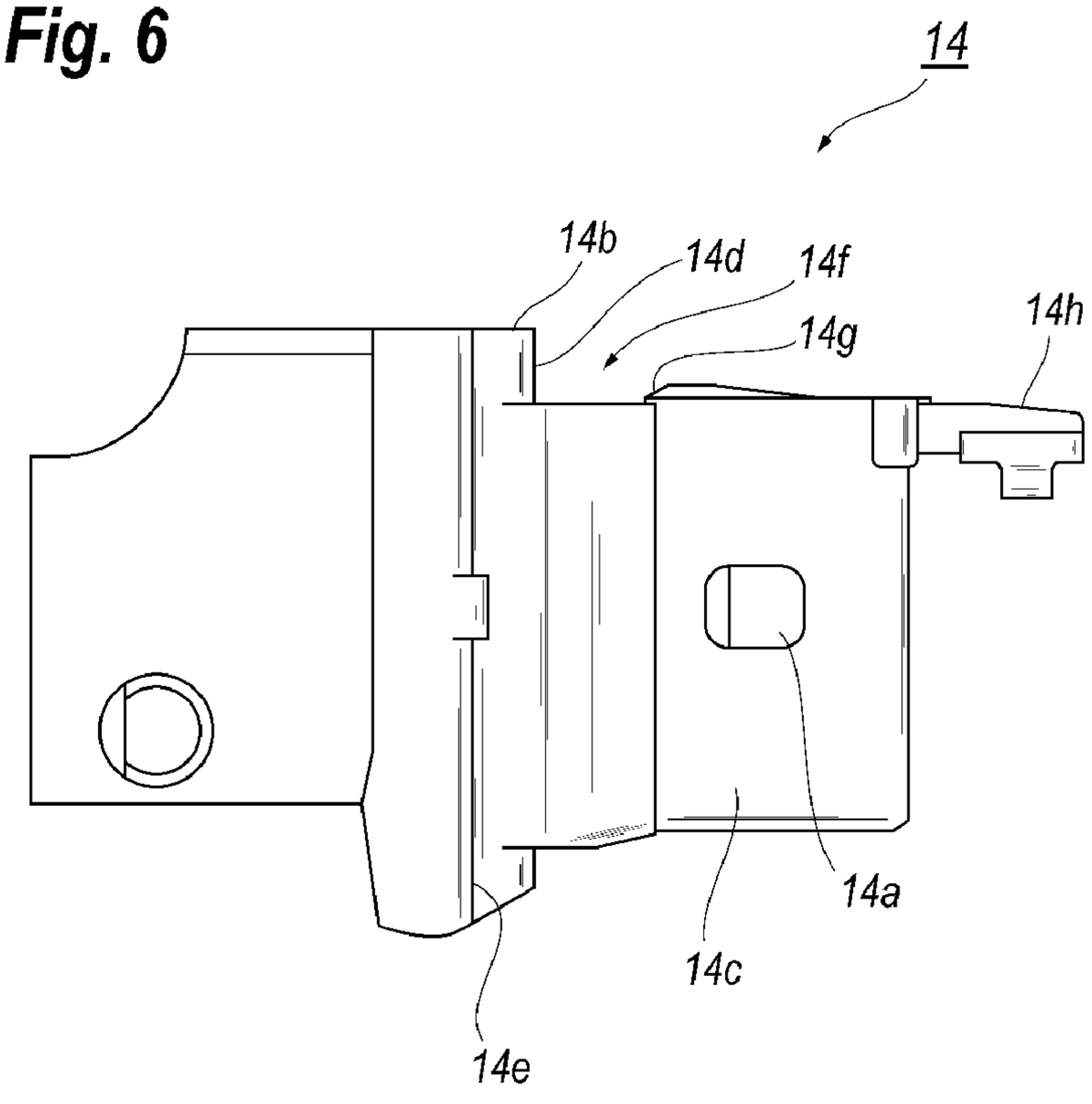

14
14b
14d
14f
14g
14h
14a
14c
14e

Fig. 7

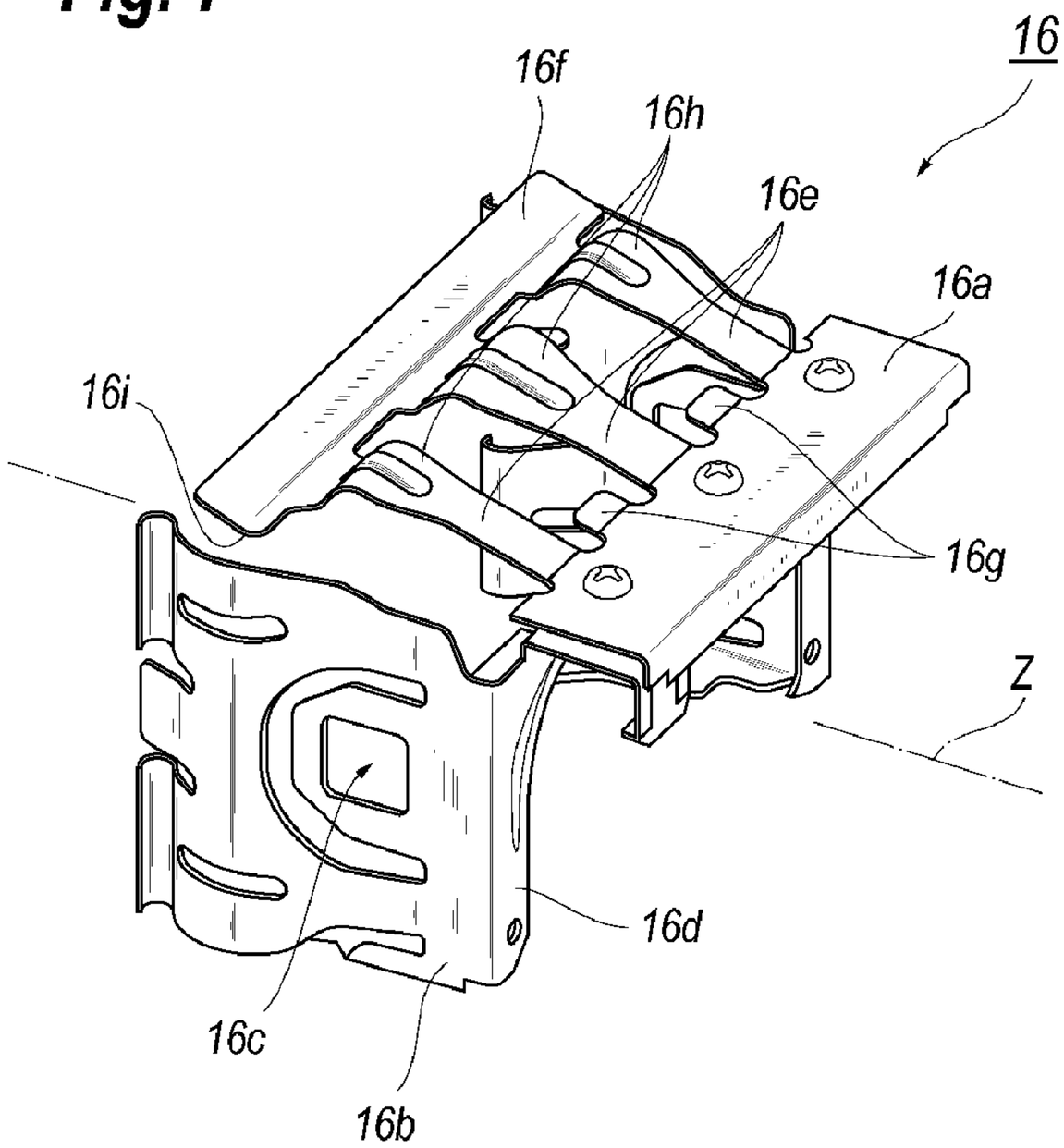
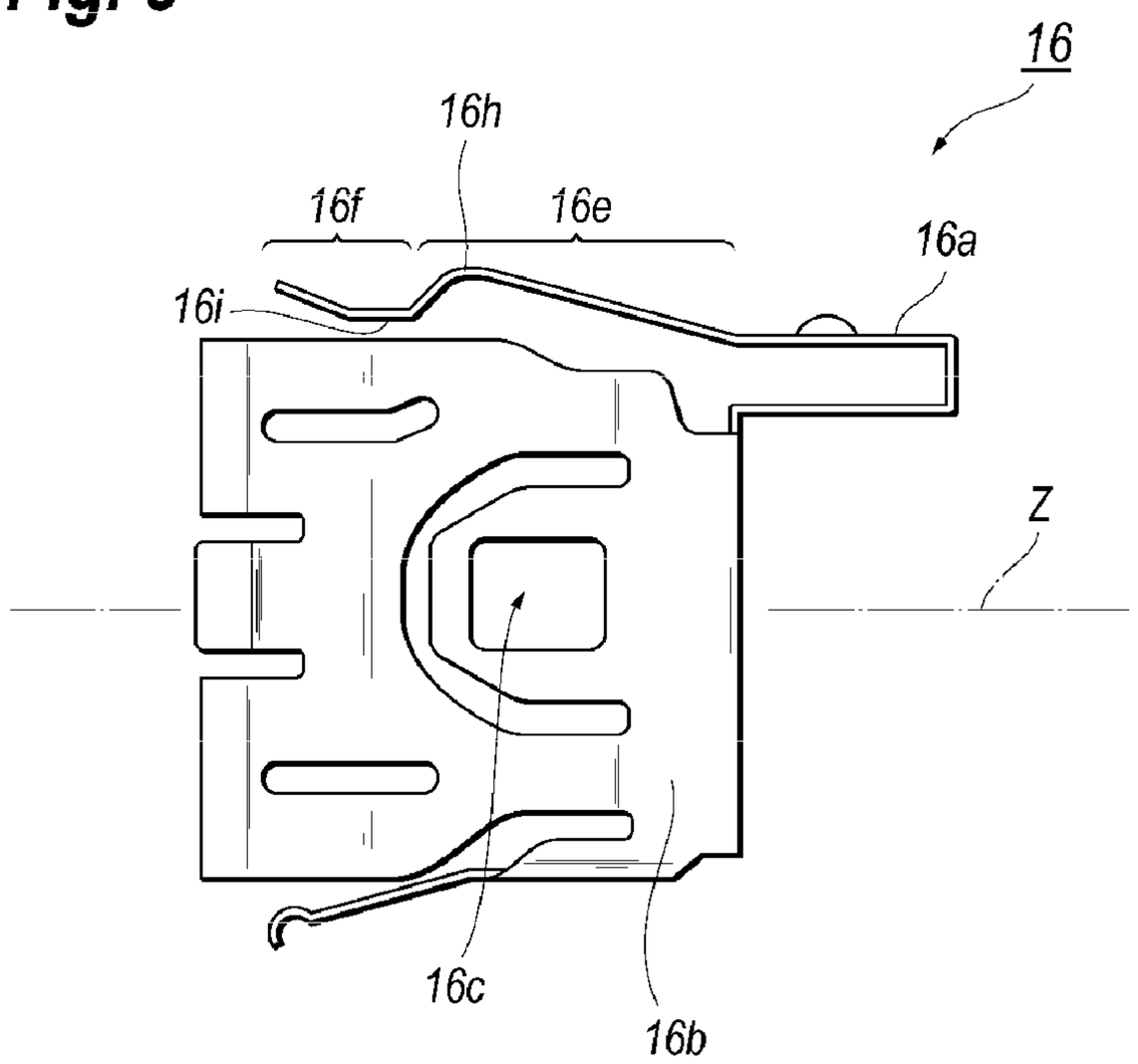

16
16f
16h
16e
16a
16i
16g
Z
16d
16c
16b

Fig. 8


16
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16e
16a
16i
Z
16c
16b

Fig. 9

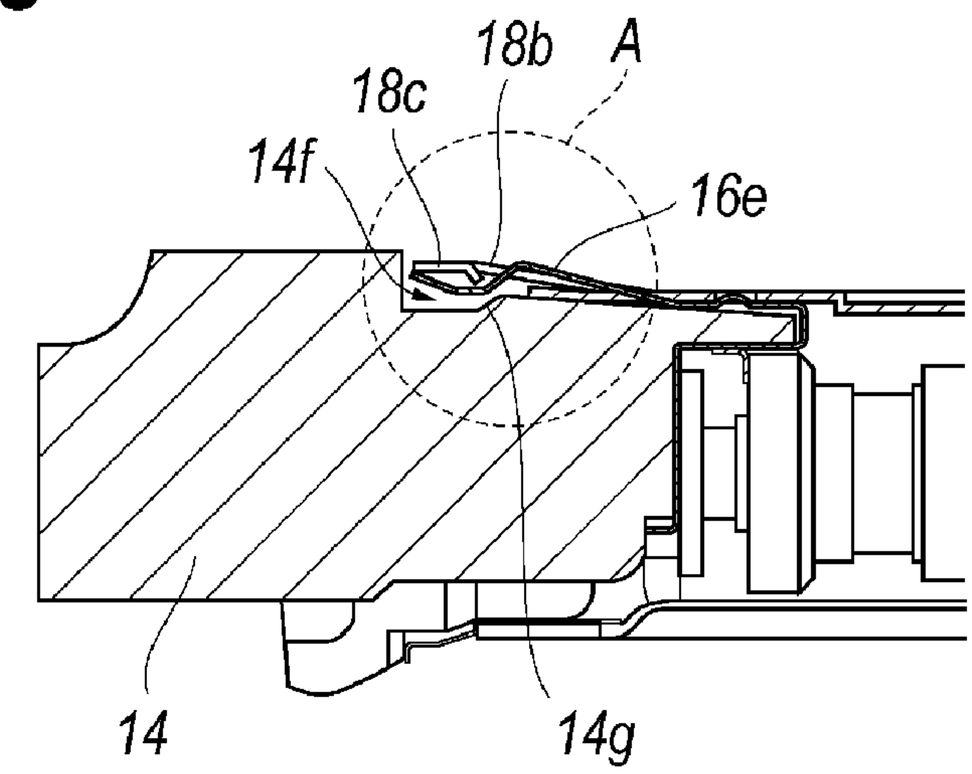

18b
A
18c
14f
16e
14
14g

Fig. 10

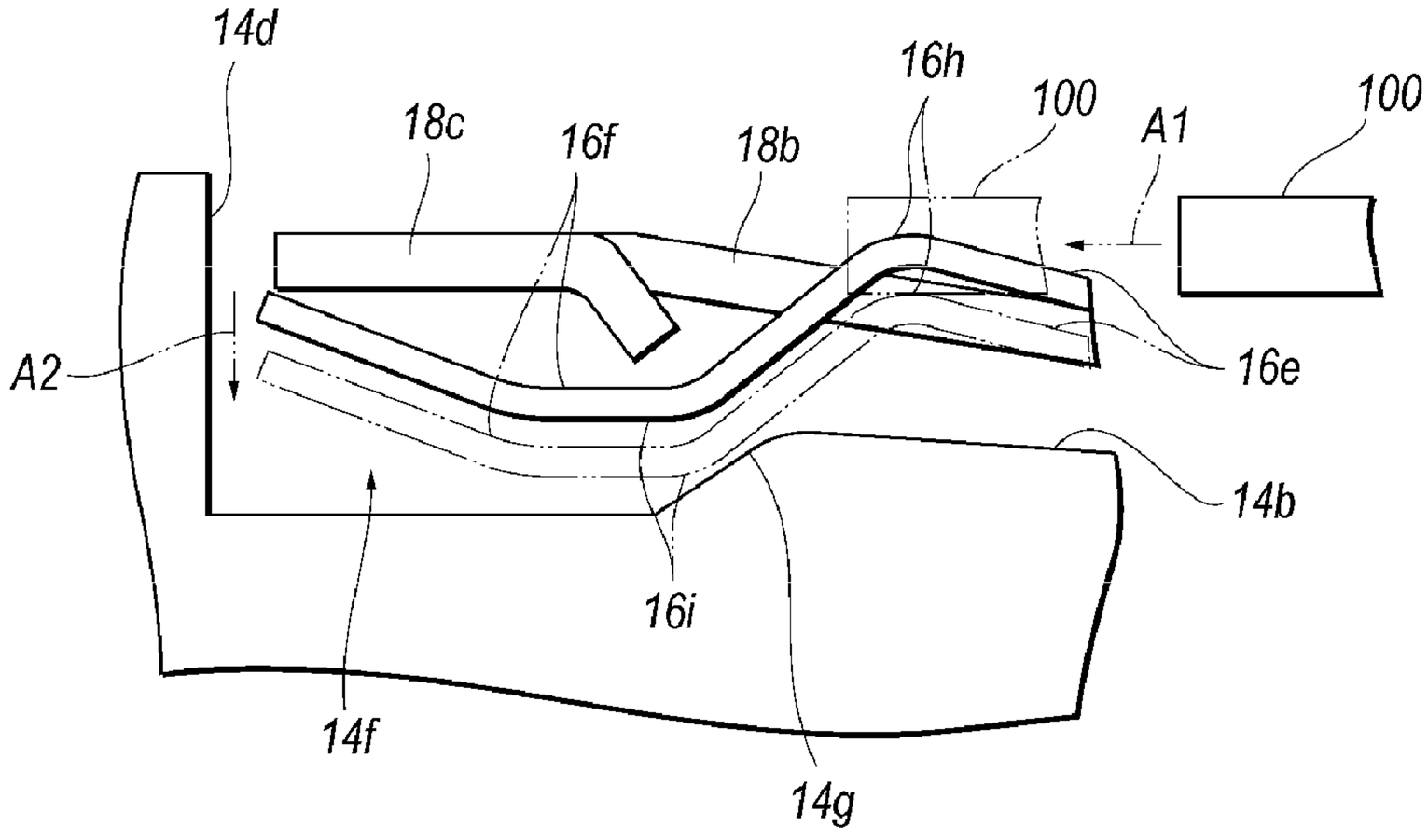

14d
18c
16f
18b
16h
100
A1
100
A2
16e
14b
16i
14f
14g

Fig. 11

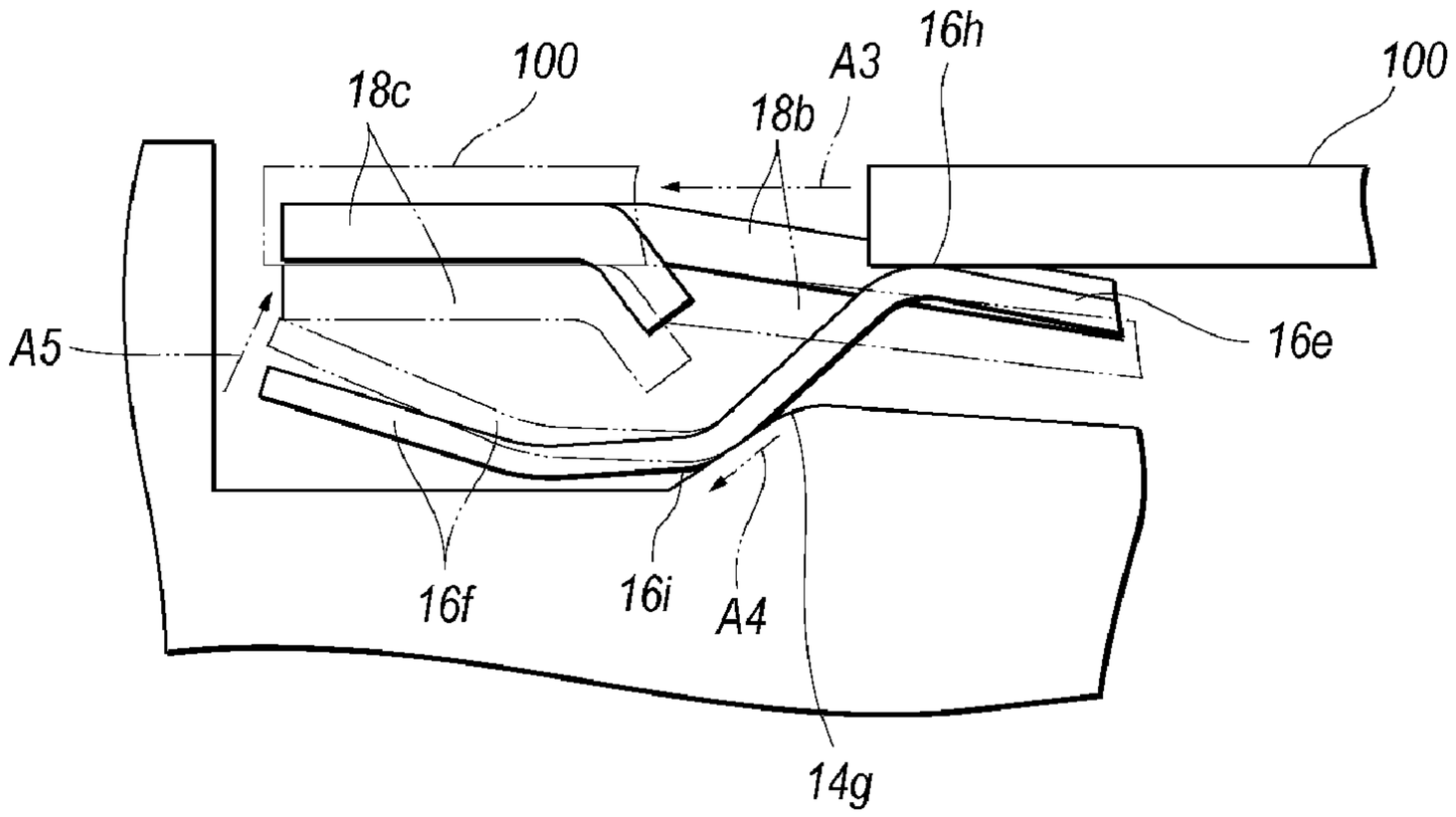
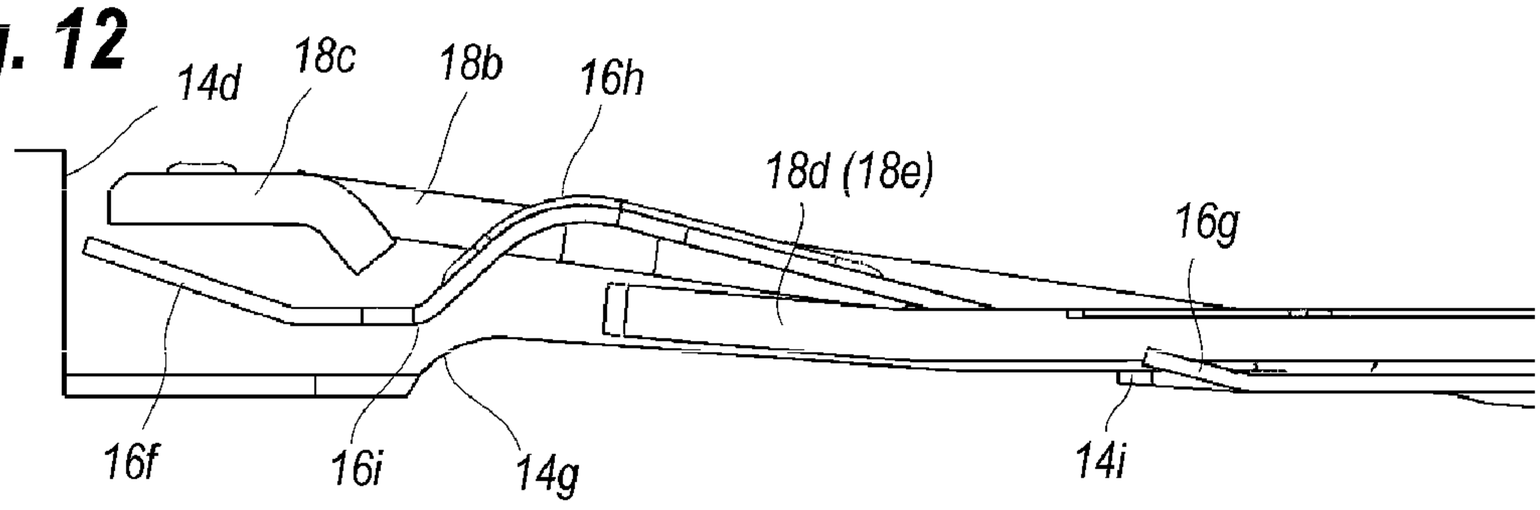

18c
100
A3
16h
18b
100
A5
16e
16f
16i
A4
14g

Fig. 12


14d
18c
18b
16h
18d (18e)
16g
16f
16i
14g
14i

OPTICAL TRANSCEIVER WITH ENHANCED EMI TOLERANCE

BACKGROUND OF THE INVENTION

1. Filed of the Invention

The present invention relates to an optical transceiver, in particular, the invention relates to an arrangement to reduce EMI radiation leaked from the optical transceiver.

2. Related Background Art

One type of an optical transceiver has been known as a pluggable optical transceiver, in which the pluggable optical transceiver is set within a cage provided on the host board from the front opening of the cage. Typical arrangements of the pluggable optical transceiver and the cage have been disclosed in, for instance, the U.S. Pat. No. 7,491,090, the U.S. Pat. No. 7,406,230 and the U.S. 2009/0176409A.

The pluggable optical transceiver typically comprises a body, a receptacle, a ground member and a cover. The body installs semiconductor optical devices, such as semiconductor laser diode (hereafter denoted as LD) and semiconductor photodiode (hereafter denoted as PD), a circuit board electrically connected with the optical devices. The receptacle, which is provided in a front portion of the body, may couple optical devices with external optical fibers secured in an optical connecter set in the receptacle. The cover installs the body therein and is assembled with the receptacle. The ground member, which covers the outer peripheral of the receptacle, provides a plurality of fingers. Setting the optical transceiver in the cage, the fingers may come in securely contact with an inside of the cage. Thus, the EMI tolerance of the optical transceiver may be enhanced. As the transmission speed of the optical communication system increases, the EMI tolerance of the optical transceiver applicable in the system has been requested in higher degree, because a signal with higher frequency components is easily radiated out from the optical transceiver.

SUMMARY OF THE INVENTION

An aspect of the present invention relates to a pluggable optical transceiver primarily comprises a receptacle made of electrically conductive material, a metal cover and a electrically conductive ground member. The metal cover includes, in a front end thereof, a first bridge extending in a direction intersecting a longitudinal direction of the optical transceiver;

and the ground member, which is assembled with the receptacle so as to surround the receptacle, includes a finer extending along the longitudinal direction and a second bridge provided in a tip of the finger. The second bridge extends in a direction substantially in parallel with the first bridge. A feature of the present invention is that the first bridge of the cover comes in contact with the second bridge of the ground member when the optical transceiver is fully set within the cage; then, two bridges may shield a gap caused between the receptacle and an inner surface of the cage.

The optical transceiver may provide a plurality of fingers in the ground member with a second tab between fingers, and a pocket in the receptacle. The second tab may be set within the pocket so as to shield a gap caused between the receptacle and the ground member. The optical transceiver may further provide a first tab in the cover. The first tab may press the second tab of the ground member set within the pocket; thus, the combination of the first and second tabs, and the pocket may

securely shield the gap between the ground member and the receptacle, and between the cover and the ground member.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be more completely understood in consideration of the following detailed description of various embodiments of the invention in connection with the accompanying drawings, in which:

FIG. **1** is a perspective view showing a pluggable optical transceiver set within the cage;

FIG. **2** is a plan view of the optical transceiver according to an embodiment of the invention;

FIG. **3** is a perspective view of the cover,;

FIG. **4** is a side view of the cover;

FIG. **5** is a perspective view of the receptacle;

FIG. **6** is a side plan view of the receptacle;

FIG. **7** is a perspective view of the ground member;

FIG. **8** is a side view of the ground member;

FIG. **9** is a cross section taken along the line IX-IX in FIG. **2**;

FIG. **10** magnifies a portion marked by a symbol "A" in FIG. **9**, in which two conditions, the convexity of the finger comes in contact with the inside of the cage and is apart therefrom, are illustrated by a chain line and a solid line, respectively

FIG. **11** also magnifies the portion "A" in FIG. **9**, in which two conditions, the first bridge comes in contact with the inside of the cage and is apart therefrom, are illustrated by a chain line and a solid line, respectively; and

FIG. **12** schematically illustrates a positional relation between the first tab, the second tab and the pocket when the optical transceiver is fully set within the cage.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Next, preferred embodiments according to the present invention will be described as referring to accompany drawings. In the description of the drawings, the same element will be referred by the same numerals or the symbols without overlapping explanations.

FIG. **1** is a perspective view showing a pluggable optical transceiver set within the cage **100** on the host system. The cage **100**, which is mounted on the board **102**, exposes the front end thereof from an opening of the face panel **104** of the host system. The optical transceiver **10** is set within the cage **100** by inserting it through the opening in the face panel **104**. The optical transceiver **100** provides two optical ports in the front end thereof, one of which is for receiving the first optical signal, while the other is for transmitting a second optical signal. Thus, the optical transceiver **100** shown in FIG. **1** performs the full synchronous optical communication.

FIG. **2** is a plan view of the optical transceiver according to an embodiment of the invention. The optical transceiver **10** provides, as already described, the receptacle **14**, the ground member **16**, and the cover **18**. In the description presented below, the front indicates a direction where the receptacle **14** is provided with respected to the cover **18**, while, the rear corresponds to a side where the cover is provided.

The body of the optical transceiver installs the semiconductor optical devices such as LD and PD, and a circuit board electrically coupled with the optical devices. The cover **18** sets the body of the optical transceiver therein.

FIG. **3** is a perspective view of the cover, and FIG. **4** is a side view of the cover **18**. The cover **18** shown in FIGS. **3** and **4** may be formed only by cutting and bending a metal sheet

without welding, soldering and so on. The cover **18** includes a primary portion **18***a* extending along the Z direction and having a rectangular cross section with respective openings in the front and rear end thereof . Within a space formed in the primary portion is installed with the circuit board.

The cover **18** further includes a pair of horns **18***b*, a first bridge **18***c*, and first tabs, **18***d* and **18***e*. The first bridge **18***c* is supported by the primary portion through respective horns. Specifically, the first bridge **18***c* extends in a direction crossing the longitudinal axis Z of the optical transceiver and connects with respective horns **18***b* at the end thereof. The horns **18***b* extends from the corner of the primary portion **18***a* along the longitudinal direction Z. The end portion of the horn **18***b*, to which the first bridge **18***c* is connected, is bent upward; accordingly, the level of the tip of the horn **18***c* positions above the ceiling of the primary portion **18***a*. Setting the optical transceiver **10** of the embodiment within the cage **100**, the horn **18***c* may come in contact with the inside of the cage **100**.

Two tabs, **18***d* and **18***e*, forwardly extends from the edge of the primary portion **18***a* and are surrounded by the horns **18***b* and the first bridge **18***c*. These tabs, **18***d* and **18***e*, as described later in the present specification, position below the second bridge **16***e*. In a case where the optical transceiver **10** is free from the cage **100**, these tabs, **18***d* and **18***e*, position below the horns **18***b* and the first bridge **18***c*. The cover **18** provides an opening **18***f* in the front end of the side wall thereof. The receptacle **14** may be assembled with the cover by mating the projection **14***a* of the receptacle **14** with the opening **18***f*.

FIG. **5** is a perspective view of the receptacle **14**, while FIG. **6** is a side plan view of the receptacle **14**. The receptacle **14**, which may be made by die-casting of a metal or made of resin coated with metal, may optically couple the optical device installed in the primary portion **18***a* with the external optical fiber. The receptacle **14** includes a top **14***b* and a side **14***c* to provide a space extending along the direction Z to couple an optical connector that implements the optical fiber with the optical device. The projection **14***a*, which may mate with the opening **18***f* of the cover **18**, is provided in the side **14***c*.

The top **14***b* and the side **14***c* each provides the stopper, **14***d* and **14***e*, that is a plane intersecting the longitudinal axis Z and facing rear. On the top **14***b* is formed with a groove **14***f*, while, the top **14***b* includes a slope **14***g* to define the groove **14***f* at the rear end thereof. Moreover, the top **14***b* provides an overhanging **14***h* at the rear end thereof. In a rear end of the receptacle **14** but the front of the overhanging **14***h* is formed with two pockets **14***i* that receive the tip of the second tab **16***g* of the ground member **16** as described later.

FIG. **7** is a perspective view of the ground member **16**, while FIG. **8** is a side view of the ground member **16**. The ground member **16** according to the present embodiment, which is to be assembled with the receptacle **14**, may be also formed only by cutting and bending a metal sheet without welding or soldering. The ground member **16** includes a rear portion **16***a* which is bent twice so as to trace the overhanging **14***h* of the receptacle **14**, and a side portion **16***b* with a shape tracing the side **14***c* of the receptacle **14**. The side portion **16***b* provides an opening **16***c* that is to be mated with the projection **14***a* to assemble the ground member **14** with the receptacle **14**. Thus, the assemble of the ground member **16** with the receptacle **14**, and that of the cover **18** with the receptacle **14**, may be carried out only by the fitting of the projection **14***a* with the opening, **16***c* or **18***f*, without welding, soldering and screwing. After the assembly of the optical devices with the receptacle **14**, the rear wall **16***d* of the ground member **16** is put between the flange of the optical device and the rear wall of the receptacle **14**.

The ground member **16** further provides a plurality of fingers **16***e*, the second bridge **16***f*, and the second tab **16***g*. The finger **16***e* forwardly extends from the front end of the upper sheet in the rear portion **16***a* along the longitudinal axis Z. The second bridge **16***f* extends to the direction intersecting the axis Z and connects the tip of the fingers **16***e*. Specifically, the finger **16***e*, upwardly extending from the upper sheet of the rear portion **16***a* and then being bent downwardly so as to form the convexity **16***h*, is connected with the second bridge **16***f* at the tip thereof . The second bridge **16***f*, first extending downwardly from the rear end thereof where the finger **16***e* is connected, is bent upwardly so as to form a hollow **16***i*. The finger **16***e* and the second bridge **16***f* integrally have a corrugated cross section with the convexity **16***h* and the hollow **16***i*, as shown in FIG. **8**. Setting the optical transceiver **10** in the cage **100**, the convexity **16***h* of the ground member **16** comes in securely contact with the inside of the cage **100**, while, the hollow **16***i* of the second bridge **16***f* comes in securely contact with the receptacle **14**.

The second tab **16***g* forwardly extends from the front end of the upper sheet in the rear portion **16***a* along the axis Z. The second tab **16***f* is to be set in the pocket **14***i* of the receptacle **14** after the ground member **16** is assembled with the receptacle **14**.

Next will describe an arrangement of the receptacle **14**, the ground member **16**, and the cover **18** when the optical transceiver **10** is set within the cage **100**. FIG. **9** is a cross section taken along the line IX-IX in FIG. **2**, while, FIG. **10** magnifies a portion marked by a label "A" in FIG. **9**, in which two conditions, the convexity **16***h* of the finger **16** comes in contact with the inside of the cage **100** and is apart therefrom are illustrated by a chain line and a solid line, respectively, and FIG. **11** also magnifies the portion "A" in FIG. **9**, in which two conditions, in which the first bridge **18***c* comes in contact with the inside of the cage **100** and is apart therefrom are illustrated by a solid line and a chain line, respectively.

As illustrated in FIGS. **9** and **10**, when the optical transceiver **10** is free from the cage **100**, the hollow **16***i* of the ground member **16** is slightly apart from the receptacle **14**.

Setting the optical transceiver **10** within the cage **100** as illustrated in FIG. **10**, which is denoted by an arrow A**1**, the convexity **16***h* of the finger **16***e* comes in contact with the inside of the cage **100**, which presses the finer **16***e* and the second bridge **16***f* of the ground member **16** downward as shown by an arrow A**2**. Then, the hollow **16***i* of the second bridge **16***f* may come in contact with the slope **14***g* of the top **14***b* of the receptacle **14**.

Further inserting the optical transceiver **10** into the cage **100** as illustrated by an arrow A**3** in FIG. **11**, the hollow **16***i* slides on the slope **14***g* downward as illustrated in an arrow A**4**; accordingly, the tip of the second bridge **16***f* is slightly lifted upward, denoted by an arrow A**5**. Still further inserting the optical transceiver **10** into the cage **100**, the first bridge **18***c* of the cover **18** may come in securely contact with the inside of the cage **100**, which presses not only the first bridge **18***c* but the horn **18***b* downward. Finally, setting the optical transceiver **10** in the defined position within the cage **100**, the first bridge **18***c* pressed downwardly and the tip of the second bridge **16***f* lifted upwardly come in contact.

After the assembly of the ground member **16** with the receptacle **14**, a slight gap is necessary between the cover **18** and the ground member **16** in order to further assemble the receptacle **14** with the cover **18**. This slight gap may cause, or degrade the EMI tolerance in a conventional optical transceiver. On the other hand, the optical transceiver **10** according to the present embodiment shuts this gap by the first bridge **18***c* and the second bridge **16***f* coming in contact with the

other, accordingly, the EMI tolerance of the optical transceiver **10** of the embodiment may be maintained in effective.

Moreover, the optical transceiver **10** of the embodiment provides a combination of the second tab **16***g* and the pocket **14** that receives the second tab **16***g* and the first tab **18***d* of the cover **18** overlaid on this combination may further suppress the degradation in the EMI tolerance.

FIG. **12** schematically illustrates a positional relation between the first tab **18***d*, the second tab **16***f* and the pocket **14***i* when the optical transceiver **10** is fully set within the cage **100**.

The second tab **16***g* is set in a space surrounded by the pocket **14***i* and the first tab **18***d*. The position of this space is between the roots of the finger **16***e*, where the countermeasure against the EMI tolerance should be firstly carried out. The optical transceiver **10** of the embodiment provides the double arrangement where the second tab **16***f* of the ground member **16** is set in the pocket **14***i* between the fingers **16***e* and the first tab, **18***d* and **18***e*, of the cover **18** presses the second tab **16***f* downward. Thus, the present optical transceiver **10** may perform the EMI tolerance even in positions between the fingers **16***e* of the ground member **16**.

In the foregoing detailed description, the apparatus of the present invention have been described with reference to specific exemplary embodiments thereof. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader spirit and scope of the present invention. The present specification and figures are accordingly to be regarded as illustrative rather than restrictive.

What is claimed is:

1. A pluggable optical transceiver to be set within a cage provided in a host system, comprising:

a receptacle made of electrically conductive material and including a slope;

a metal cover including a first bridge in a front end thereof, said first bridge extending in a direction intersecting a longitudinal direction of said optical transceiver; and

an electrically conductive ground member surrounding a periphery of said receptacle, said ground member including a finger extending in said longitudinal direction and a second bridge connected on a tip of said finger, said second bridge extending in a direction substantially in parallel with said first bridge, said finger including a convexity, said second bridge including a hollow,

wherein, when said optical transceiver is set within said cage, said convexity comes in contact with an inner surface of said cage, and said hollow comes in contact with said slope and slides thereon, and

wherein said first bridge comes in contact with said second bridge when said optical transceiver is fully set within said cage.

2. The pluggable optical transceiver of claim **1**,

wherein said first bridge and said second bridge shield a gap between said receptacle and an inner surface of said cage when said optical transceiver is fully set within said cage.

3. The pluggable optical transceiver of claim **1**,

wherein said second bridge is lifted up to come in contact with said first bridge when said optical transceiver is fully set within said cage.

4. The pluggable optical transceiver of claim **1**,

wherein said finger and said second bridge integrally have an S-shaped cross section.

5. The pluggable optical transceiver of claim **1**,

wherein said cover includes a pair of horns each forwardly extending from a front corner of said cover, said first bridge connecting a tip of said horns.

6. The pluggable optical transceiver of claim **1**,

wherein said finger includes a plurality of fingers each extending in said longitudinal direction, said second bridge connecting a tip of said respective fingers.

7. The pluggable optical transceiver of claim **6**,

wherein said cover further includes a first tab, said ground member further includes a second tab, and said receptacle includes a pocket to receive said second tab,

wherein said first tab comes in contact with said second tab set within said pocket,

wherein said first tab and said second tab shield a gap between said cover and said ground member.

8. The pluggable optical transceiver of claim **1**,

wherein said ground member is made of metal sheet only by cutting and bending without any welding and soldering.

9. The pluggable optical transceiver of claim **1**,

wherein said cover is made of metal sheet only by cutting and bending without any welding and soldering.

10. A pluggable optical transceiver to be set within a cage provided in a host system, comprising:

a receptacle made of electrically conductive material and including a slope;

a metal cover including a first bridge in a front end thereof, said first bridge extending in a direction intersecting a longitudinal direction of said optical transceiver; and

an electrically conductive ground member surrounding a periphery of said receptacle, said ground member including a finger extending in said longitudinal direction and a second bridge connected on a tip of said finger, said second bridge extending in a direction substantially in parallel with said first bridge, said finger including a convexity, said second bridge including a hollow,

wherein, when said optical transceiver is set within said cage, said convexity comes in contact with an inner surface of said cage, and said hollow comes in contact with said slope and slides thereon, and

wherein said second bridge is lifted up and comes in contact with said first bridge when said optical transceiver is fully set within said cage.

* * * * *